

# *Colorado Greenhouse Gas Inventory*

*Data to 2015, Report released 2019*

*Air and Waste Management Association Presentation  
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# Overview

- Greenhouse Gas (GHG) Background
- Colorado GHG Inventory Background
- Colorado Inventory Results

# Common Greenhouse Gases

- Carbon Dioxide (CO<sub>2</sub>):
  - *Source*: living organisms, burning of fossil fuels, industrial processes
- Methane (CH<sub>4</sub>):
  - *Source*: coal formations, oil and gas development, landfills, livestock digestive processes, decomposing waste
- Nitrous Oxide (N<sub>2</sub>O):
  - *Source*: fuel burning, fertilizer manufacturing

# Common Greenhouse Gases

- Fluorinated Gases:

- *Includes:* ozone depleting substances (ODS), hydrofluorocarbons, perfluorocarbons, sulfur hexafluoride, and nitrogen trifluoride
- *Source:* refrigeration, industrial processes

<https://www.epa.gov/ghgemissions/overview-greenhouse-gases>

# Global Warming Potential (GWP)

- Compares the climate change impact of different gases
- A factor that reflects how long a specific gas is likely to remain in the atmosphere and how strongly it absorbs energy
- CO<sub>2</sub> is the standard reference with a GWP of 1; potential of other gases calculated relative to CO<sub>2</sub> and expressed as CO<sub>2</sub> equivalent (CO<sub>2</sub>e)
- Standard values taken from International Panel on Climate Change (IPCC) periodic Assessment Reports

<https://www.epa.gov/ghgemissions/understanding-global-warming-potentials>

# IPCC Fourth Assessment Report GWP and Time Horizons

Gas	20-yr	100-yr*	500-yr
CH <sub>4</sub>	72	25	7.6
N <sub>2</sub> O	289	298	153
Fluorinated compounds**	17 to 16,300	5 to 22,800	1 to 32,600

\*EPA reporting programs require 4th AR, 100-yr time horizon GWP factors, referenced in 40 CFR 98.2(b)(4), Table A-1

\*\*Warming potential range depends on specific compound

# Reporting CO<sub>2</sub>e Emissions

GHG	x	GWP	=	CO <sub>2</sub> e
1 MT CO <sub>2</sub>	x	1	=	1 MT CO <sub>2</sub> e
1 MT CH <sub>4</sub>	x	25	=	25 MT CO <sub>2</sub> e
1 MT N <sub>2</sub> O	x	298	=	298 MT CO <sub>2</sub> e
1 MT HFC-23	x	14,800	=	14,800 MT CO <sub>2</sub> e
1 MT PFC-14	x	7,390	=	7,390 MT CO <sub>2</sub> e
1 MT SF <sub>6</sub>	x	22,800	=	22,800 MT CO <sub>2</sub> e

GHG emissions usually expressed in metric tons (MT) or million metric tons (MMT)

Note: APCD tracks most emissions in short tons

# GHG Emissions Reporting

There are multiple EPA reporting programs, as well as reports issued by other entities, and emissions numbers are rarely consistent between reports. Reasons for differences include:

- Reporting criteria - thresholds, specific industry or activity
- Activity Data - different accounting methods, grouping
- Calculation methods - different emission factors, emission factor vs. monitoring data, scaling or apportionment
- Units of measure - short tons vs. metric tons



# Colorado GHG Inventory Background

# Colorado GHG Inventory History

- Several inventories completed since 1990
- Recent inventories have been updated on a 5-year schedule
- 2014 revision used the EPA State Inventory Tool (SIT) with data through 2010 and projections to 2030
- 2019 revision uses the EPA SIT with data through 2015 and projections to 2030
- Future inventories will incorporate new directives

# Reported GHG Emissions

- Snapshot in time
- Uses aggregate statewide data, cannot extract county-level results
- Estimated using the EPA State Inventory Tool (SIT)
- Emission factors based on IPCC and EPA guidance
- Activity data from national databases
  - Some state-specific
  - Some national, apportioned to states

# EPA State Inventory Tool Strengths

- Consistency between states and over time
- Spreadsheet-based, modular format
- Calculation methods follow IPCC guidance
- Incorporates periodic updates to methodology and data
- Estimates from 1990 baseline to most recent data year
- Provides default activity data and emission factors
- Projects future emissions to 2030

# EPA State Inventory Tool Limitations

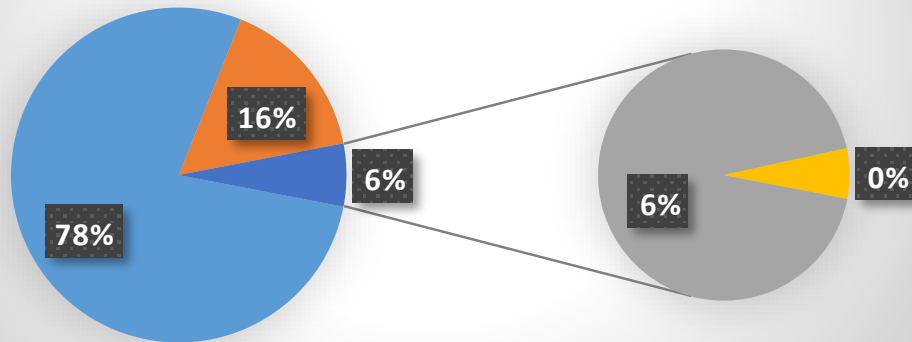
- Default data from national sources
  - Data lag of 3-5 years
  - Not all data is state-specific
  - Data may be incomplete
- Projections use different methodology than historic
  - Future activity or emissions estimated at a national level then apportioned to states based on population or historic activity
- Some model calculations and data are not accessible
- Limited ability to assess policy impacts

# Colorado Inventory Estimates

# Colorado GHG Emissions by Gas: 1990, 2015

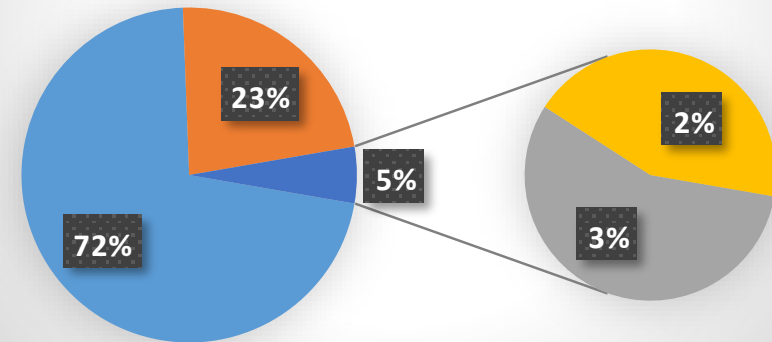
## 1990 GHG Emissions by Gas 84 MMT CO<sub>2</sub>e

■ CO<sub>2</sub> ■ CH<sub>4</sub> ■ N<sub>2</sub>O ■ HFC's

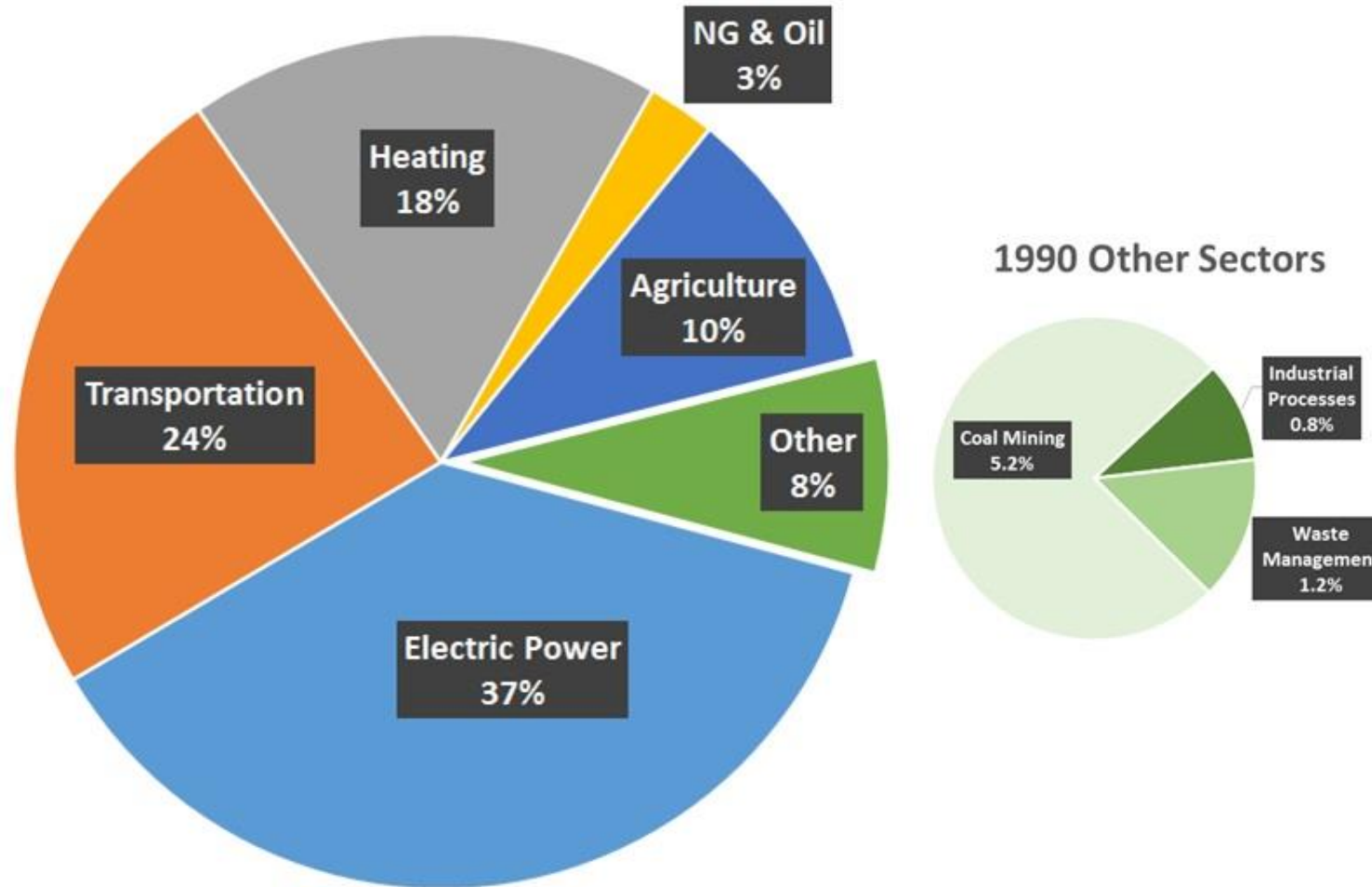


## 2015 GHG Emissions by Gas 127 MMT CO<sub>2</sub>e

■ CO<sub>2</sub> ■ CH<sub>4</sub> ■ N<sub>2</sub>O ■ HFC's

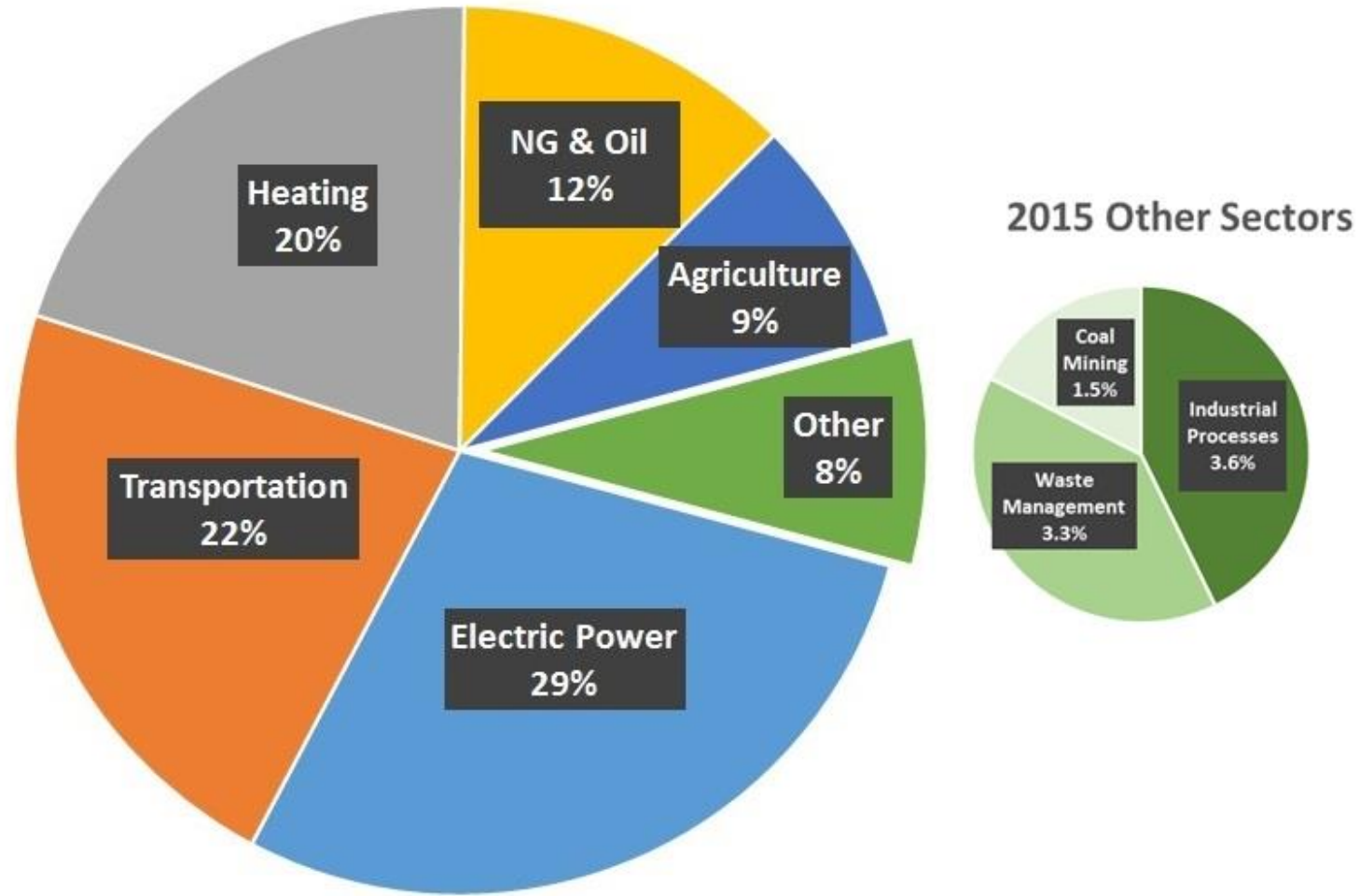


# 1990 GHG by Sector - 84 MMT CO<sub>2</sub>e





# 2015 GHG by Sector - 127 MMT CO<sub>2</sub>e

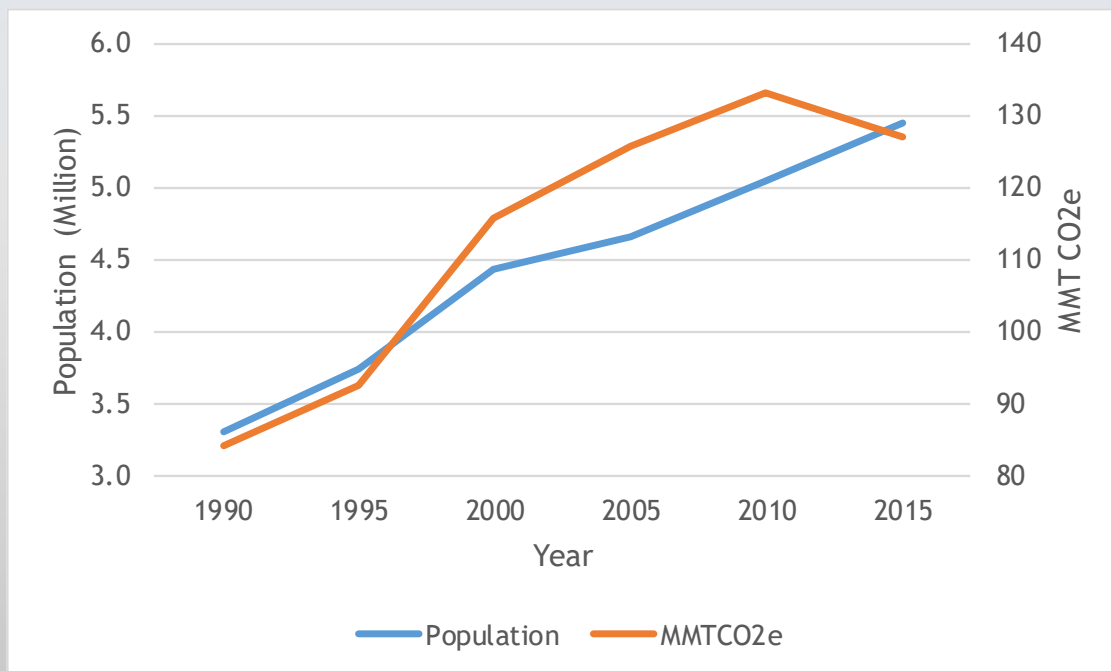


# Colorado GHG Emissions by Sector with Projections to 2030

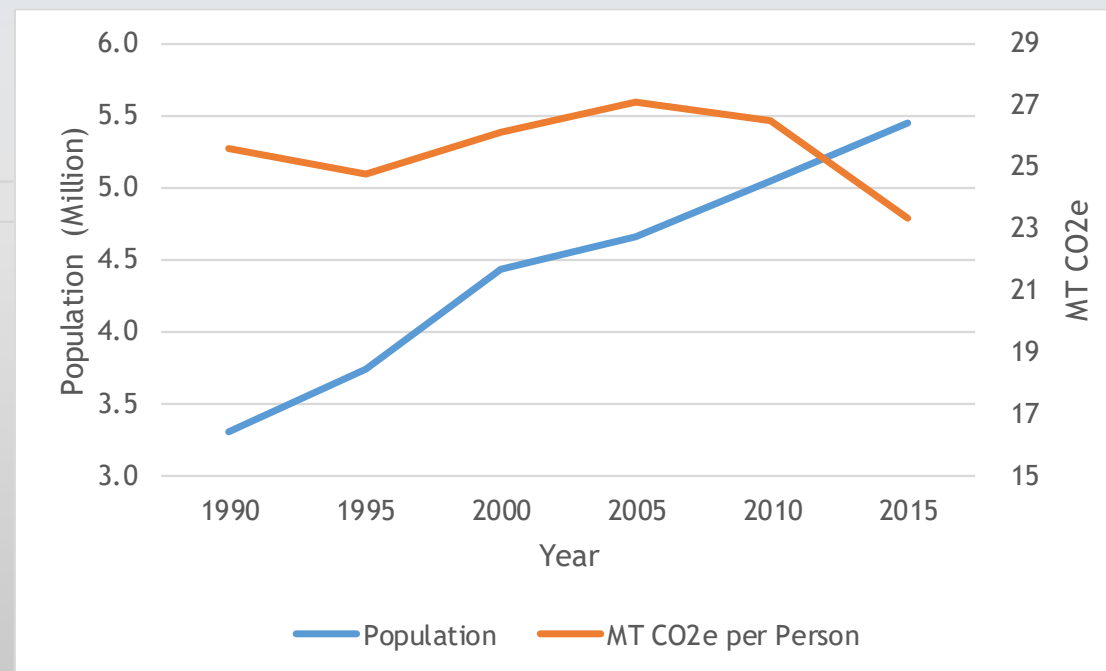
Emissions by Sector (MMT CO <sub>2</sub> e)	1990	1995	2000	2005	2010	2015	2020	2025	2030
Electric Power	31.4	32.7	38.8	40.3	39.5	36.3	31.0	25.4	25.5
Transportation	20.1	23.7	27.0	30.8	29.8	28.2	31.4	30.8	30.0
Heating	15.0	17.9	20.0	24.6	26.2	25.7	24.8	25.7	26.1
Natural Gas and Oil	2.2	2.5	6.5	8.1	12.0	15.6	6.8	7.5	7.4
Agriculture	8.6	9.3	13.4	9.6	10.1	10.7	10.4	9.4	9.1
Coal Mining	5.2	3.8	5.5	6.8	8.1	1.9	6.0	6.1	6.6
Industrial Processes	0.7	1.4	3.0	3.2	3.7	4.5	3.0	3.6	3.9
Waste Management	1.0	1.1	1.5	2.4	3.6	4.2	4.7	5.4	6.1
<b>Grand Total</b>	<b>84.1</b>	<b>92.4</b>	<b>115.8</b>	<b>125.7</b>	<b>133.0</b>	<b>127.0</b>	<b>118.2</b>	<b>114.1</b>	<b>114.7</b>

# State Population and GHG Emissions

## Population and Emissions

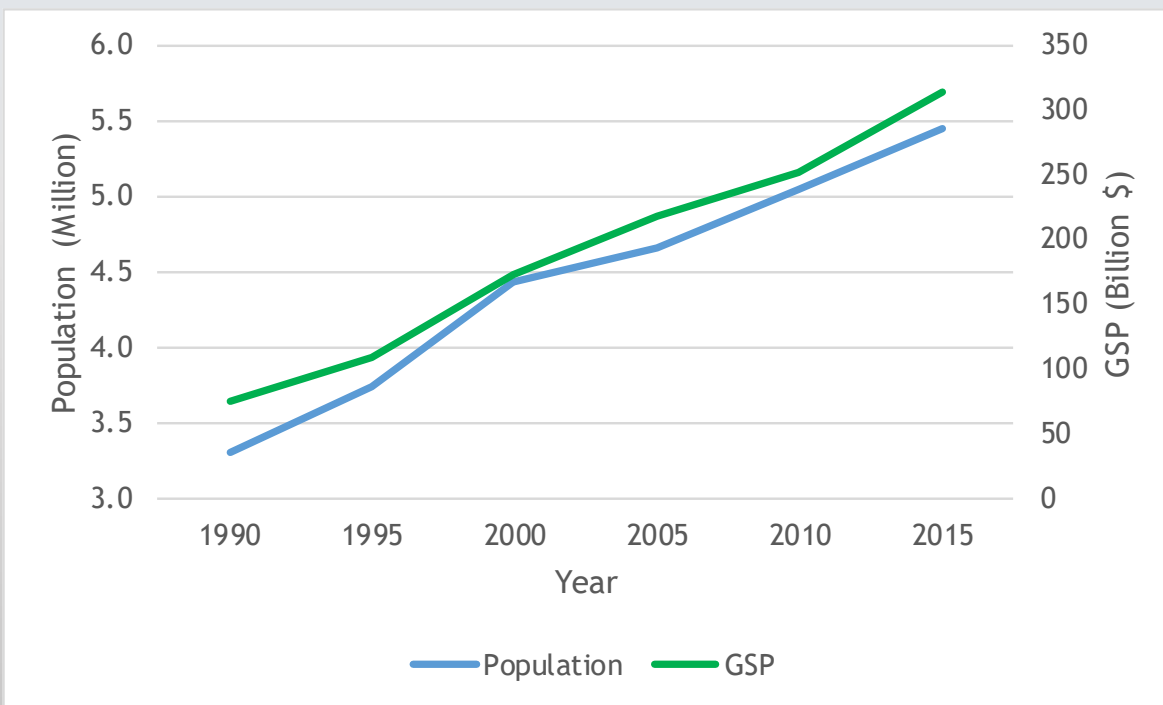


## Population and per Capita Emissions

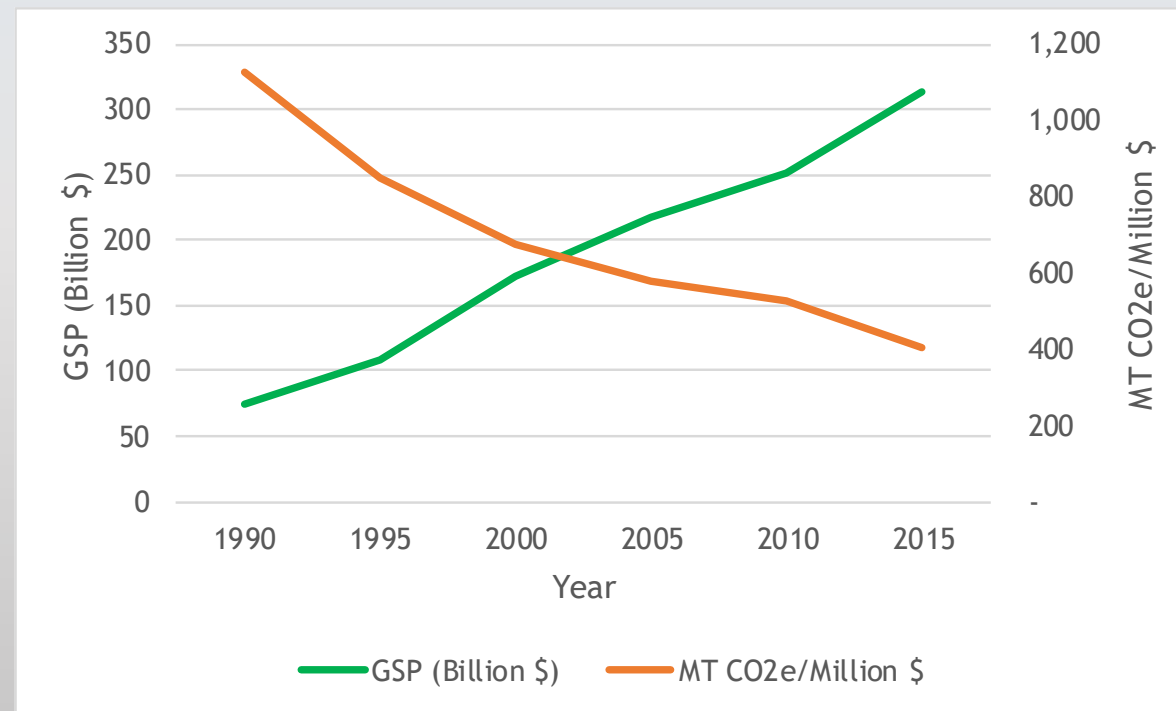


# Gross State Product and GHG Emissions

## Population and GSP



## Emissions Relative to GSP

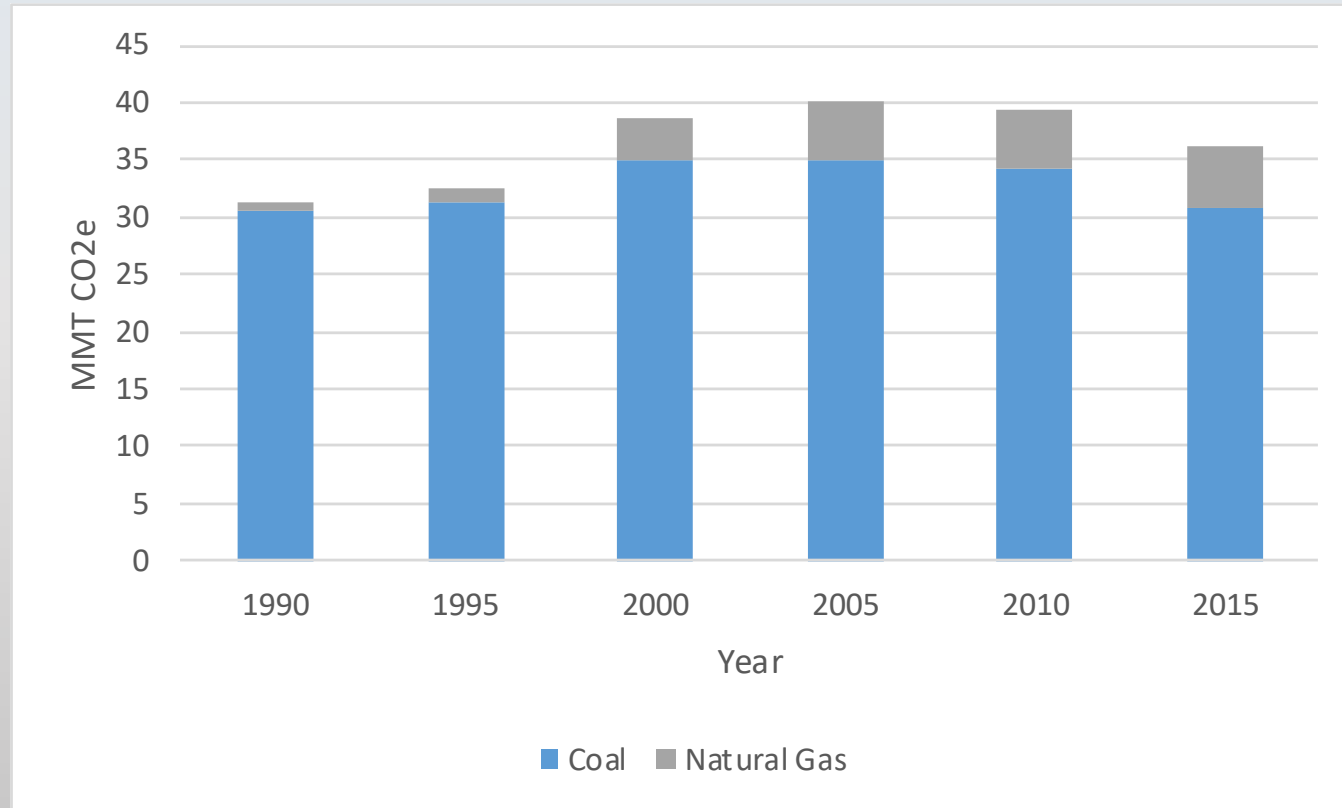


# Fuel Combustion for Electric Generation

Emissions (MMTCO <sub>2</sub> e)	1990	1995	2000	2005	2010	2015
Coal CO <sub>2</sub>	30.538	31.209	35.012	35.003	34.289	30.841
Petroleum CO <sub>2</sub>	0.022	0.016	0.085	0.019	0.016	0.006
Natural Gas CO <sub>2</sub>	0.713	1.278	3.544	5.086	5.051	5.274
<b>Subtotal CO<sub>2</sub> Emissions</b>	<b>31.272</b>	<b>32.502</b>	<b>38.641</b>	<b>40.108</b>	<b>39.356</b>	<b>36.121</b>
N <sub>2</sub> O	0.144	0.147	0.170	0.171	0.168	0.151
CH <sub>4</sub>	0.008	0.009	0.011	0.012	0.012	0.011
<b>Subtotal CO<sub>2</sub>e Emission</b>	<b>0.152</b>	<b>0.156</b>	<b>0.182</b>	<b>0.183</b>	<b>0.179</b>	<b>0.162</b>
<b>Total CO<sub>2</sub>e Emissions</b>	<b>31.425</b>	<b>32.659</b>	<b>38.823</b>	<b>40.291</b>	<b>39.535</b>	<b>36.283</b>

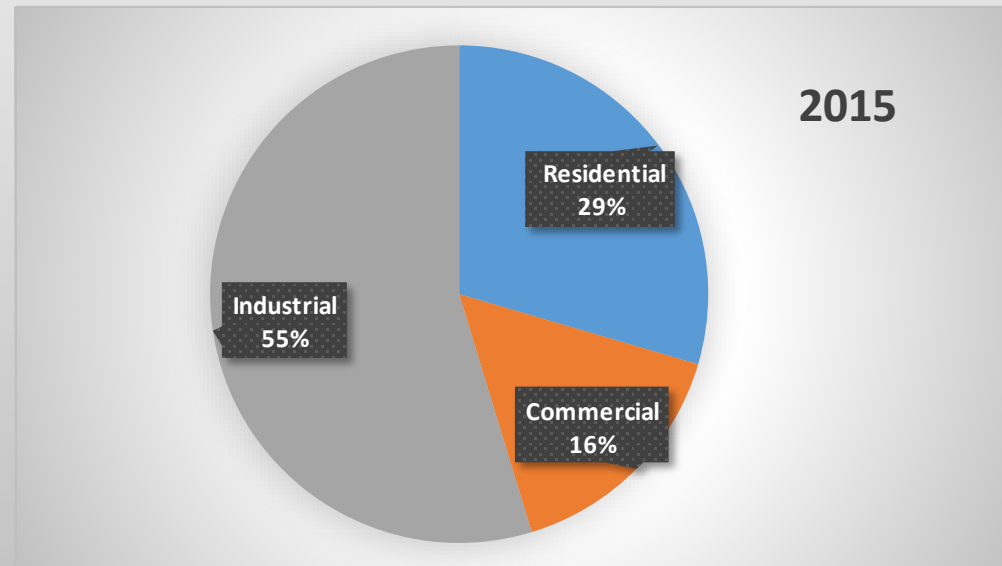
# Electric Generation

## MMT CO2e by Fuel



# Fossil Fuels Burned for Heating

Emissions (MMTCO <sub>2</sub> e)	1990	1995	2000	2005	2010	2015
Residential	5.416	6.236	6.978	7.696	7.943	7.593
Commercial	4.008	4.061	3.822	4.115	4.269	4.045
Industrial	5.610	7.599	9.229	12.833	13.978	14.055
<b>Total CO<sub>2</sub>e Emissions</b>	<b>15.034</b>	<b>17.896</b>	<b>20.028</b>	<b>24.643</b>	<b>26.190</b>	<b>25.692</b>



# Transportation

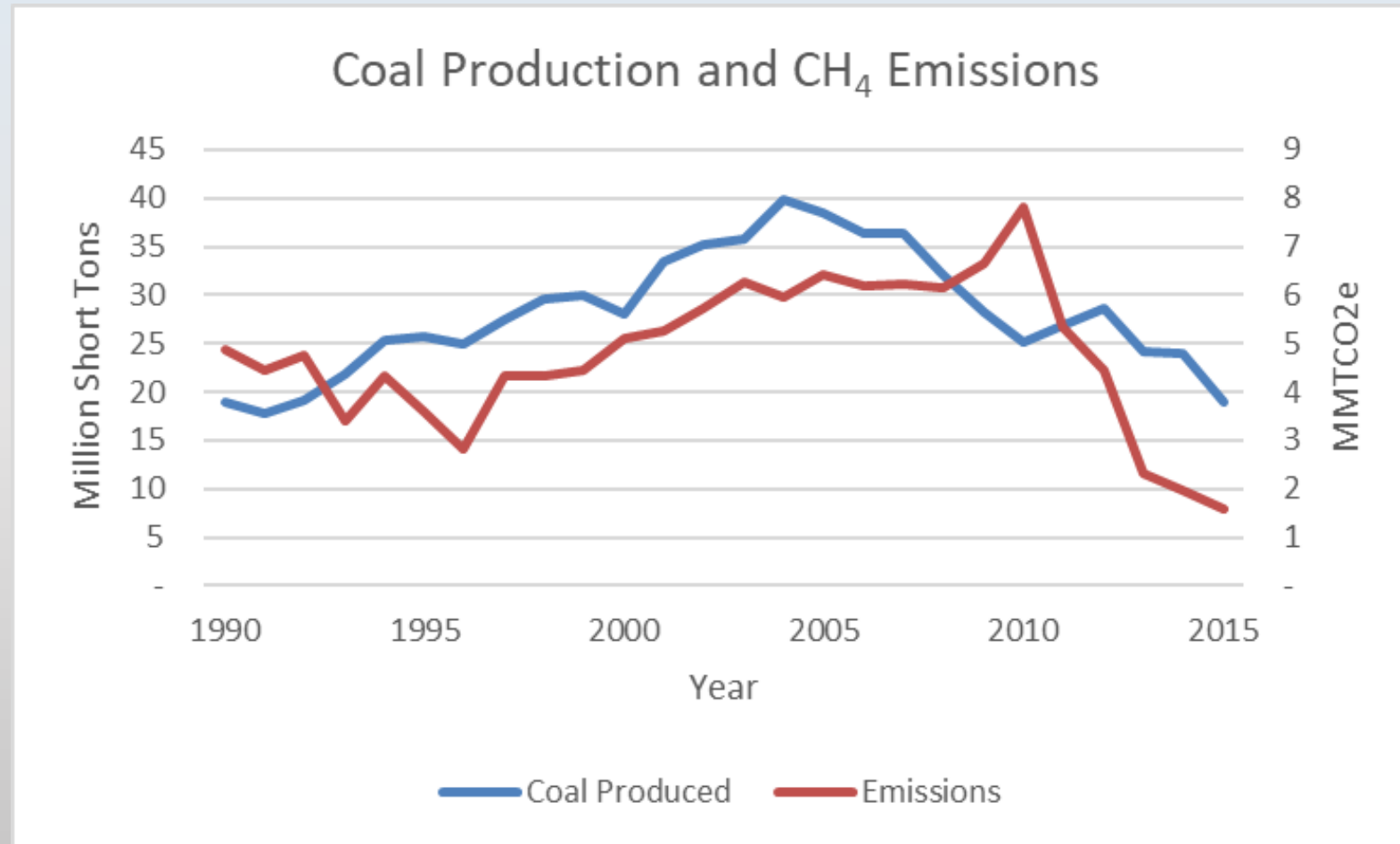
Emissions (MMTCO <sub>2</sub> e)	1990	1995	2000	2005	2010	2015
<b>Direct CO<sub>2</sub> Emissions by Fuel Type</b>						
Petroleum	18.669	21.813	25.195	29.099	28.482	27.314
Natural Gas	0.486	0.617	0.519	0.734	0.774	0.521
<b>Subtotal CO<sub>2</sub> Emissions</b>	<b>19.154</b>	<b>22.430</b>	<b>25.714</b>	<b>29.834</b>	<b>29.256</b>	<b>27.835</b>
<b>CH<sub>4</sub> and N<sub>2</sub>O Emissions (MMT CO<sub>2</sub>e)</b>						
Gasoline Highway Emissions	0.890	1.224	1.228	0.863	0.415	0.236
Diesel Highway Emissions	0.004	0.006	0.008	0.008	0.010	0.006
Non-Highway Emissions	0.046	0.058	0.059	0.076	0.075	0.081
Alternative Fuel Vehicle Emissions	0.003	0.004	0.006	0.006	0.009	0.010
<b>TOTAL CO<sub>2</sub>e EMISSIONS</b>	<b>20.097</b>	<b>23.723</b>	<b>27.015</b>	<b>30.787</b>	<b>29.764</b>	<b>28.168</b>



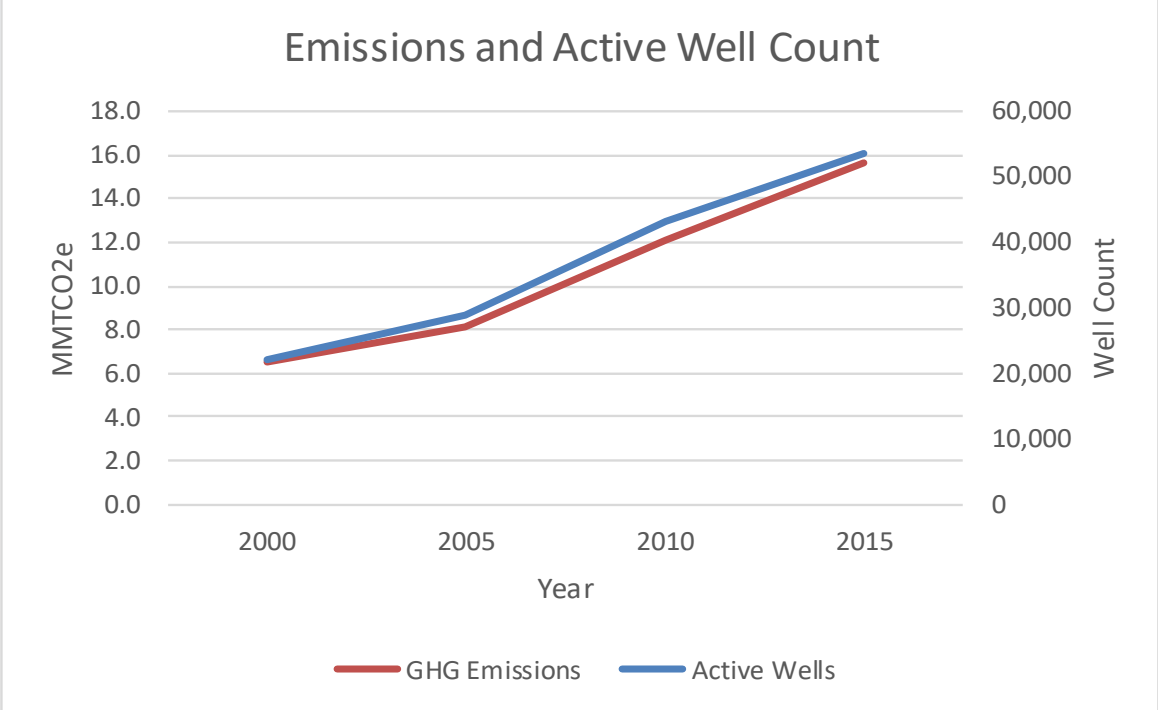
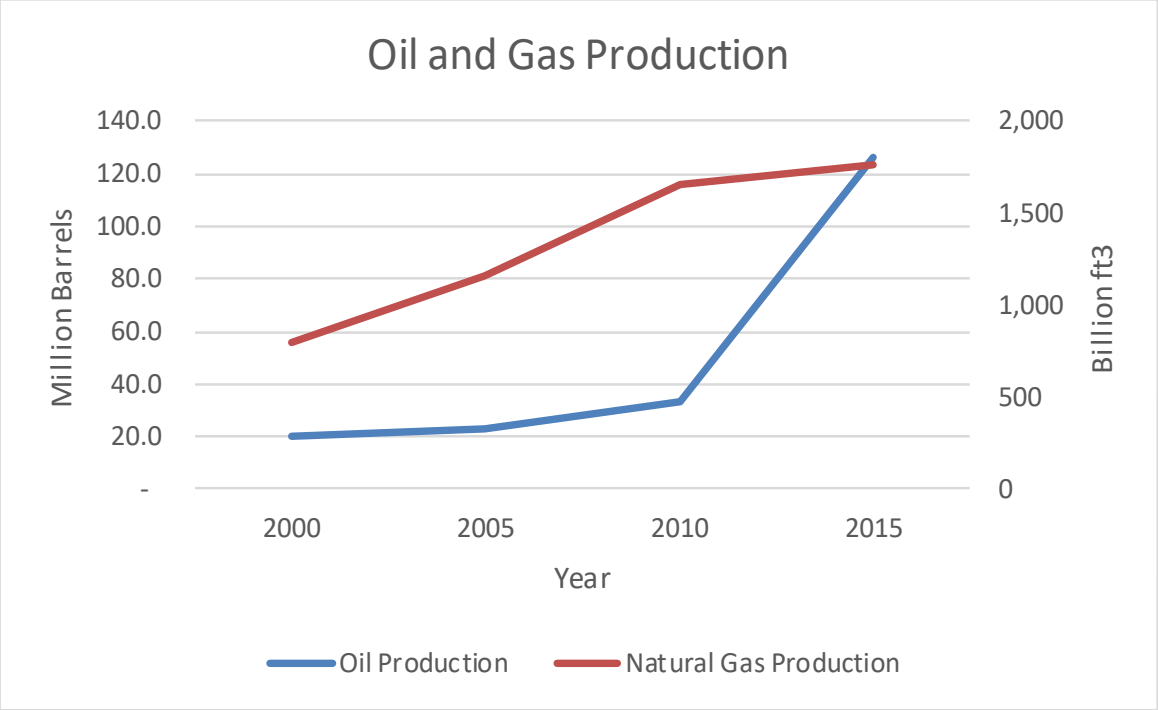
# Industrial Processes

Emissions (MMTCO <sub>2</sub> e)	1990	1995	2000	2005	2010	2015
Carbon Dioxide						
Cement Manufacture	0.317	0.476	0.554	0.623	0.559	0.769
Lime Manufacture	0.000	0.100	0.095	0.295	0.276	0.365
Limestone and Dolomite Use	0.000	0.018	0.028	0.031	0.005	0.010
Soda Ash	0.036	0.038	0.041	0.041	0.036	0.035
Iron & Steel Production	0.000	0.000	0.750	0.340	0.305	0.305
Urea Consumption	0.003	0.003	0.002	0.004	0.004	0.007
<b>Subtotal CO2 Emissions</b>	<b>0.356</b>	<b>0.635</b>	<b>1.470</b>	<b>1.334</b>	<b>1.185</b>	<b>1.490</b>
HFC, PFC, and SF6 Emissions						
ODS Substitutes	0.004	0.440	1.184	1.574	2.305	2.861
Semiconductor Manufacturing	0.064	0.112	0.142	0.137	0.102	0.097
Electric Power Transmission and Distribution Systems	0.262	0.218	0.159	0.109	0.083	0.060
<b>Subtotal CO2e Emissions</b>	<b>0.330</b>	<b>0.770</b>	<b>1.485</b>	<b>1.820</b>	<b>2.490</b>	<b>3.018</b>
<b>TOTAL CO2e EMISSIONS</b>	<b>0.687</b>	<b>1.405</b>	<b>2.955</b>	<b>3.154</b>	<b>3.675</b>	<b>4.508</b>

# Coal Mining



# Natural Gas and Oil Production



# Agriculture

	1990	1995	2000	2005	2010	2015
<b>Emissions by Category</b>						
Enteric Fermentation	4.566	5.101	7.698	5.314	5.957	6.187
Manure Management	0.971	1.169	1.968	1.497	1.623	1.843
Agricultural Soil Management	3.085	3.036	3.746	2.768	2.482	2.625
Agricultural Residue Burning	0.005	0.006	0.004	0.003	0.006	0.005
<b>TOTAL EMISSIONS (MMTCO<sub>2</sub>e)</b>	<b>8.627</b>	<b>9.313</b>	<b>13.416</b>	<b>9.582</b>	<b>10.069</b>	<b>10.660</b>
<b>Emissions by Gas (MMTCO<sub>2</sub>e)</b>						
CH <sub>4</sub>						
Enteric Fermentation	4.566	5.101	7.698	5.314	5.957	6.187
Manure Management	0.447	0.600	1.281	0.895	1.038	1.202
Agricultural Residue Burning	0.004	0.005	0.003	0.003	0.005	0.004
<b>Subtotal CH<sub>4</sub></b>	<b>5.017</b>	<b>5.705</b>	<b>8.983</b>	<b>6.211</b>	<b>6.999</b>	<b>7.392</b>
N <sub>2</sub> O						
Manure Management	0.524	0.570	0.687	0.602	0.586	0.642
Agricultural Soil Management	3.085	3.036	3.746	2.768	2.482	2.625
Agricultural Residue Burning	0.001	0.001	0.001	0.001	0.001	0.001
<b>Subtotal N<sub>2</sub>O</b>	<b>3.610</b>	<b>3.607</b>	<b>4.433</b>	<b>3.370</b>	<b>3.069</b>	<b>3.267</b>

# Waste Management

Emissions (MMTCO <sub>2</sub> e)	1990	1995	2000	2005	2010	2015
<b>CH<sub>4</sub> Emissions from Landfills</b>	0.566	0.657	0.994	1.797	2.964	3.519
<b>CH<sub>4</sub> and N<sub>2</sub>O Emissions from Wastewater (MMTCO<sub>2</sub>e)</b>						
Municipal CH <sub>4</sub>	0.265	0.299	0.347	0.373	0.404	0.436
Municipal N <sub>2</sub> O	0.097	0.112	0.133	0.142	0.150	0.167
Industrial CH <sub>4</sub>	0.048	0.061	0.065	0.053	0.065	0.065
<b>Total Emissions from Wastewater</b>	0.409	0.473	0.544	0.568	0.619	0.668
<b>Total Waste Management</b>	0.976	1.129	1.538	2.366	3.583	4.186

# Future Inventories

In accordance with Senate Bill 19-096, the Air Pollution Control Division will engage in ongoing initiatives to improve the quality and usefulness of the greenhouse gas inventory.

# GHG Emission Reductions

- Emission reduction efforts have largely been focused on control strategies for traditional regulated sources
- GHG emissions are impacted by the decisions and actions of millions of individuals in their daily lives, presenting significant challenges to emission reduction

# Questions?

Sign up to receive email notifications:

<https://www.colorado.gov/pacific/cdphe/air-mailing-lists>